National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

AIRS-MLS Upper Tropospheric Water Vapor Comparisons

Eric Fetzer

Jet Propulsion Laboratory, California Institute of Technology

AIRS Science Team Meeting, Greenbelt, MD

27 September 2006

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Executive Summary

AIRS-MLS upper trop. water vapor

- **Excellent agreement (~30% RMS; <5% bias) at 250 hPa for non-polar latitudes.**
- **Poorer agreement at 300, 200 & 150 hPa**
  - ***Different sampling distributions.***
  - ***MLS ~30% dry at 300 hPa.***
- **Ranked statistics (e. g. medians, percentiles) often agree despite large RMS differences**
  - ***Highly non-gaussian data with many outliers***
- **AIRS less sensitive in stratosphere and tropical upper troposphere**
  - ***AIRS may have NO skill (except climatology) down to 300 hPa over poles.***
  - ***Some sensitivity to 150 hPa in tropics.***
- **MLS appears *more* strongly affected by (ice) clouds than is AIRS.**
  - ***Most pronounced in the moist tropics***
  - ***Later data versions may fix this.***

Eric.J.Fetzer@jpl.nasa.gov

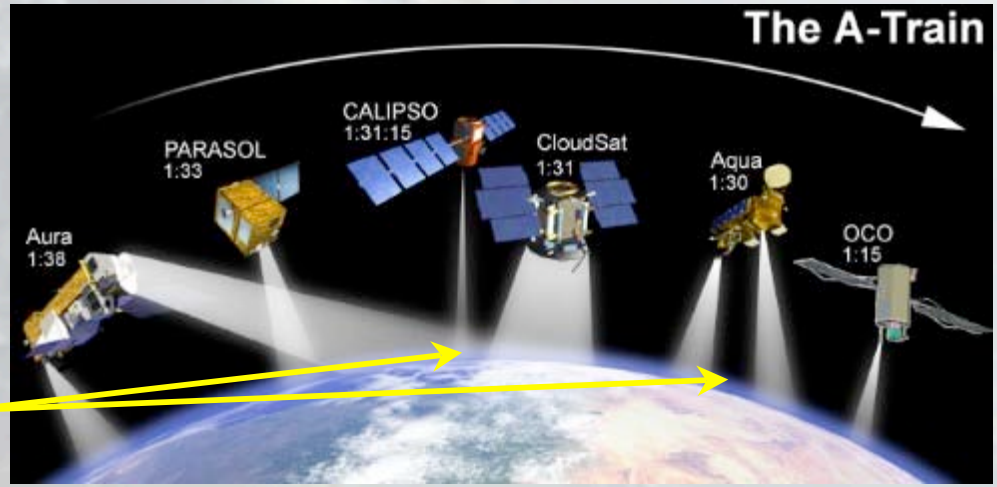
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

The Instruments

- *AIRS*: **Atmospheric Infrared Sounder on *Aqua***
  - ***Sensitive to ~0.1 mm total water (10-20 ppmv in Gettelman et al. 2004, GRL).***

- *MLS*: **Microwave Limb Sounder on *Aura***
  - ***Water vapor from 316 hPa upward.***
  - ***Sensitive down to very low amounts (a few ppmv).***



The samples are *minutes* apart.

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Some Questions

- **Where do AIRS and MLS have similar water vapor observing characteristics?**
  - ***Looked at distributions, ranked statistics, summaries (mean, std. dev.), correlation, linearity.***
- **Where (and why) do they observe differently?**
- **What are the effects of clouds on sampling?**
- **How do these vary between seasons?**
  - ***Look at all AIRS-MLS matches for 2005.***

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Use Nearest Neighbor Matching

Why:

- **The goal of this work is reconciling the two data sets**
  - ***~25% RMS & ~5% bias are 'close enough'***
- ***Sampling effects of clouds are critical to understanding climatologies***
  - ***Both instrument flag 'undesirable' scenes. Keep track of these...***

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

More Matching Issues...

- **Count only AIRS-MLS match-ups.**
  - ***This under-represents AIRS sampling by a factor of ~100.***

- **Place both data sets on the AIRS standard levels of 300, 250, 200 and 150 hPa.**
  - ***AIRS: geometric mean of layers.***
  - ***MLS: Log(mixing ratio) linear in Log(p).***

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Quality Flagging

- **Both instruments use quality flags**
  - ***AIRS***
    - Scattering of microwaves by precipitation, or cloud cover greater than 50-70%.
      - *Use* Qual_Temp_Profile_Mid *= 0.*
  - ***MLS***
    - Microwave scatter from ice particles larger than ~10 microns.
      - *Use* Quality *>5.0 at 316 hPa, >0.3 above*

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

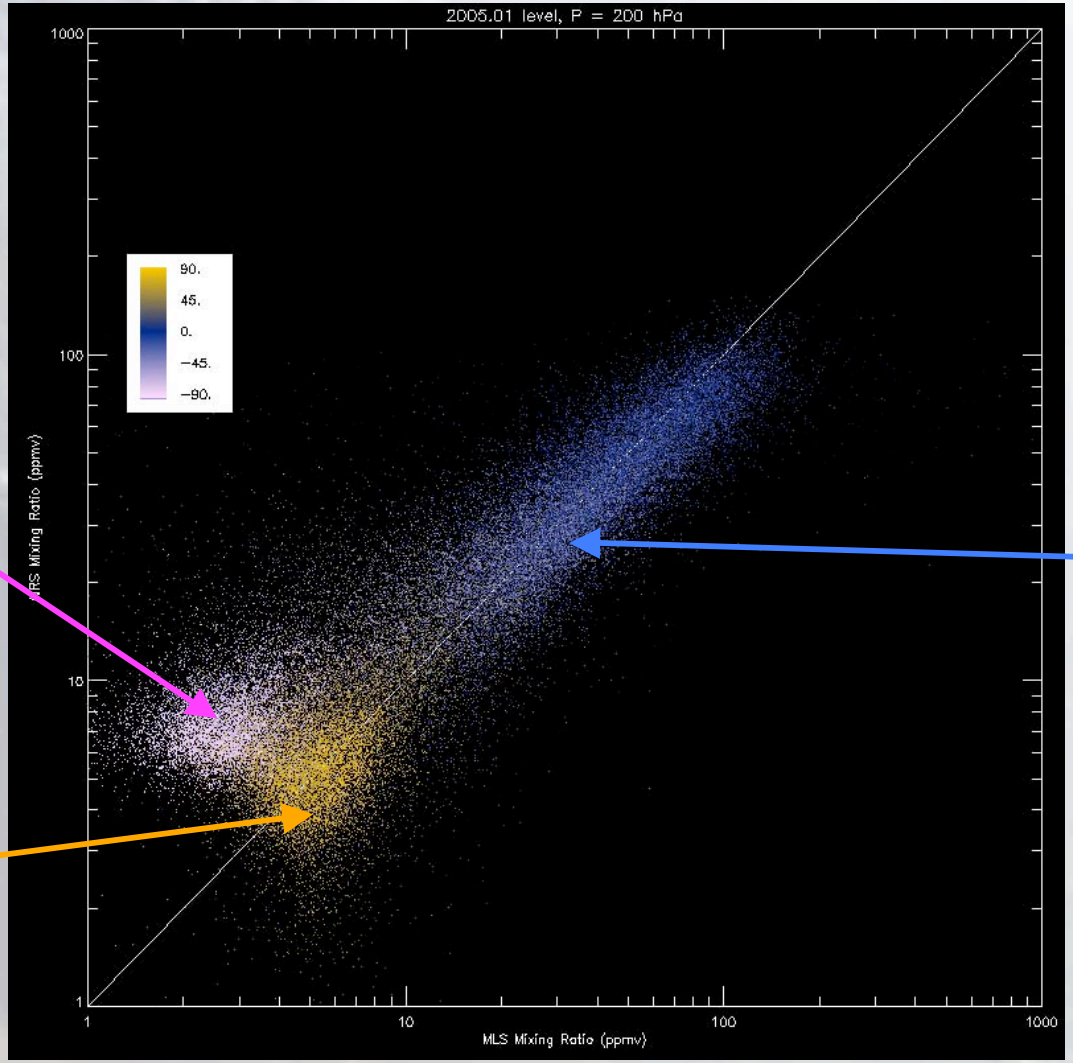
First Lesson: Important to exclude AIRS water vapor above tropopause

AIRS versus MLS at 200 hPa

Exclude these:

South Polar, above AIRS tropopause

North Polar, above AIRS tropopause (agree in the mean).



Keep these

Non-polar, beneath AIRS tropopause

Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Sampling by month and latitude

- **Examine:**
  - ***Twelve months in 2005.***
  - ***Twelve 15-degree latitude bands.***
  - ***Four pressures: 300, 250, 200 & 150 hPa.***

- **We see:**
  - ***AIRS is often 'stratospheric' down to 300 hPa over poles.***
  - ***Many familiar regions of poorer AIRS yields:***
    - Subtropical stratus.
    - Midlatitude storms.
    - Polar regions in summer.

  - ***Both AIRS and MLS have low yields in regions of deep convection***
    - Very important for MLS ice-water vapor climatologies.

Eric.J.Fetzer@jpl.nasa.gov

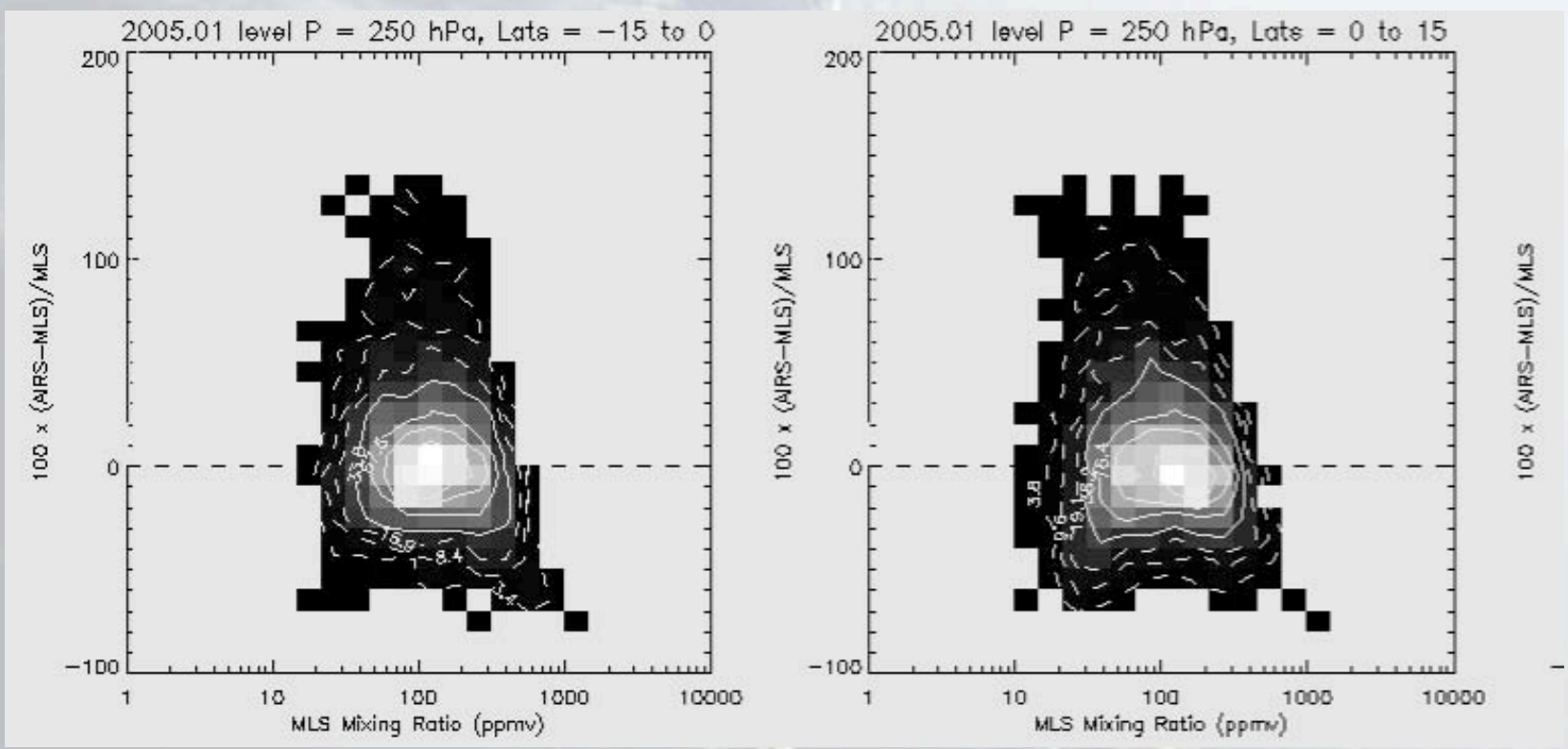
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Tropics, 250 hPa

Small biases, RMS agreement to ~30% for all months

Relative differences roughly constant with amount



Eric.J.Fetzer@jpl.nasa.gov

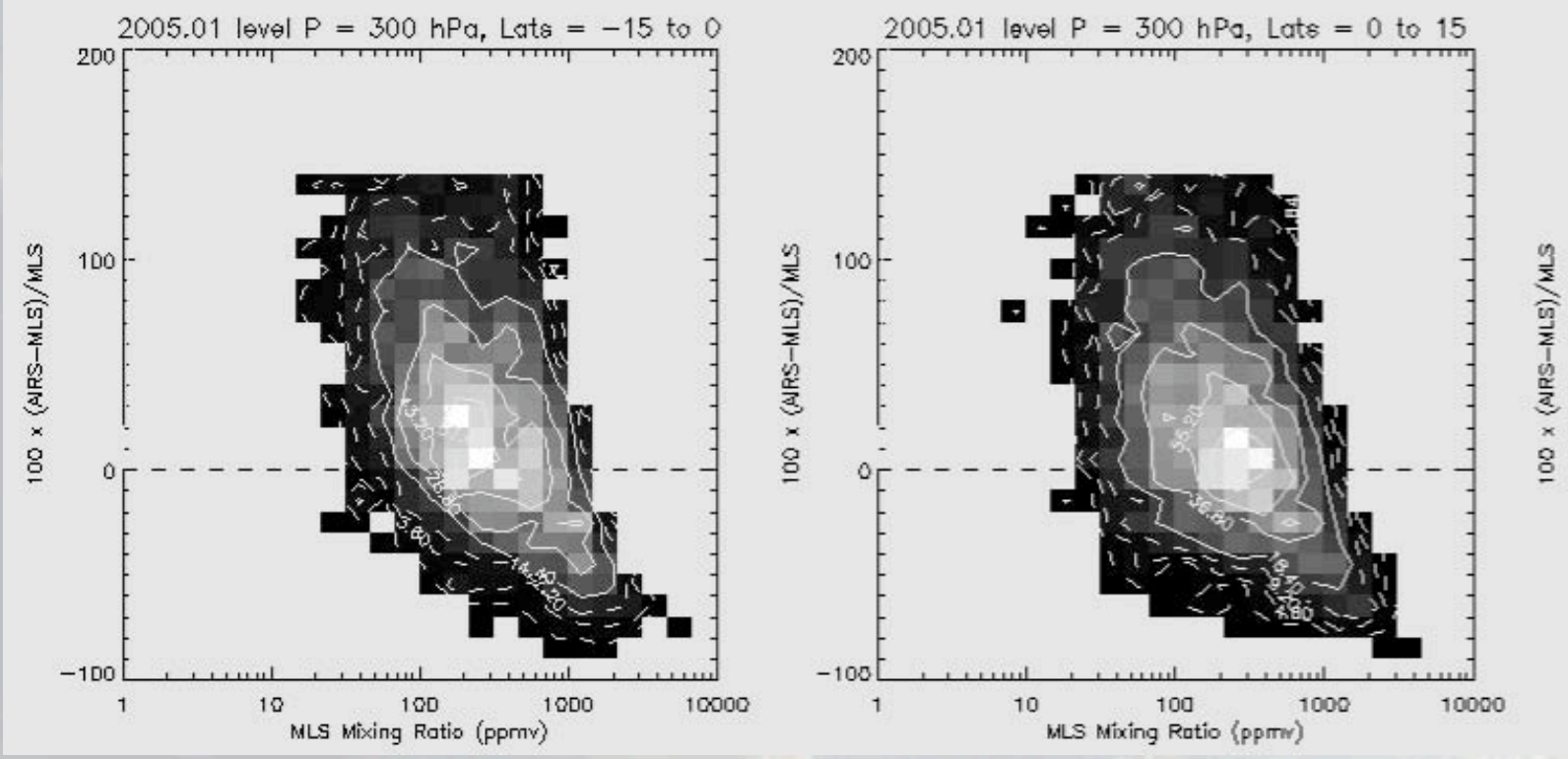
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Tropics, 300 hPa

Agreement *poorer* than at 250 hPa
MLS ~30% drier

Relative differences vary with amount



Eric.J.Fetzer@jpl.nasa.gov

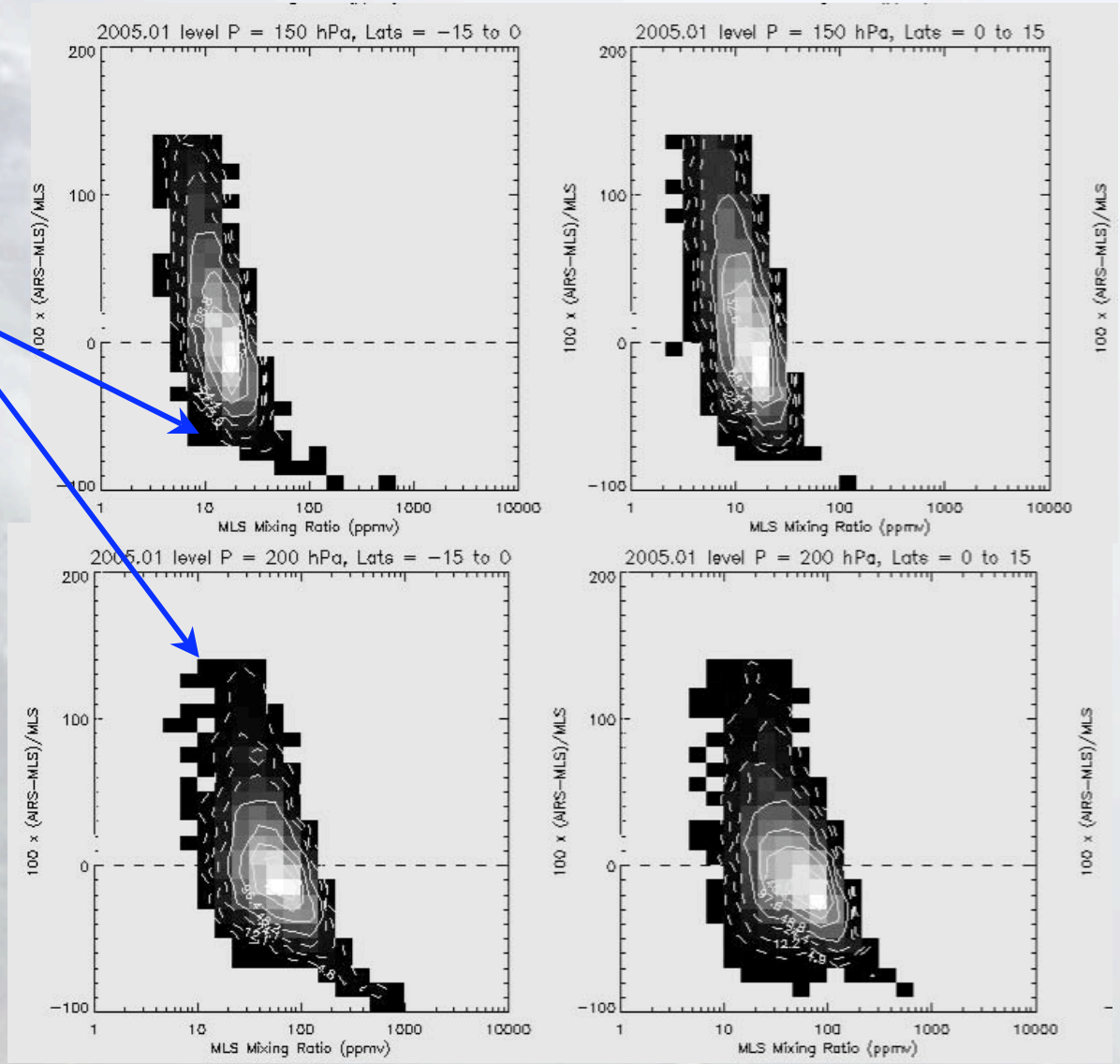
National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Tropics, 200 & 150 hPa
Differences vary with amount

NOTE: Sensitivity threshold varies with height!

Gettelman et al., 2004, GRL say it's constant at 10-20 ppmv.



Eric.J.Fetzer@jpl.nasa.gov

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Conclusions and Future Work

- **Agreement to a few percent in mean, 25% RMS at 250 hPa**
  - ***consistent with MLS-CFH sonde results by Holger Vömel, Costa Rica.***
- **MLS dry bias of ~30% at 300 hPa noted by Vömel, others**
  - ***Tobin shows AIRS dry bias of 10%.***
- **Mixed results at 200 & 150 hPa**
  - ***Low-end insensitivity by AIRS could explain this.***
- **Examining effects of cloud sampling**
  - ***Complementary data sets in tropics***
    - MLS misses much water vapor -- but samples ice!
    - AIRS nicely samples water vapor.
- **Manuscript(s) currently in preparation.**

Eric.J.Fetzer@jpl.nasa.gov